CENTRAL INTELLIGENCE AGENCY

INFORMATION REPORT

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50X1-HUM

COUNTRY East Germany

SUBJECT Production of Frequency Modulation Equipment at Werk fuer Fernmeldewesen HF, Berlin-Oberschoeneweide

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GENERAL

1. One of the principal projects in the transmitter development section at HF Werk, Berlin (formerly Oberspreewerk) was the design and construction of 10 250-watt frequency modulation transmitters to be installed at the following locations in the Soviet Zone:

Leipzig (in service 1 May 1953), Brocken/Harz(installed in January 1952), Berlin (installed in 1952), Inselberg (near Eisenach), Schwerin, Demmin/Pomerania, Magdeburg, Salzwedel, Halle and Berlin II.

Transmitters at the first three of these locations were in operation in July 1953.

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2. It was planned that successive amplifier stages would be added to these transmitters to increase the output power eventually to 10 kilowatts. This was planned to be done in the following steps, principal advantage of which is that, with correct design, variations 250 watts to 1 kilowatt do not have any effect on the mean frequency. By this method, the reactance tubes will be modulated only 1 kilowatt to 3 kilowatts a given frequency variation, and by correct selection of a working point it is possible to avoid the 3 kilowatts to 10 kilowatts is necessary in view of the high demands made on the transmitter with respect to a small

3. [redacted] all 10 transmitters had been delivered to the above locations. The major difficulty in putting 50X1-HUM them in operation concerned the antennas. [redacted] 50X1-HUM they were produced at HF Werk of HF Werk, however, did not have the manpower to install them, so re this task was turned over to the Postal Department. 50X1-HUM

4. [redacted] the 1-kilowatt transmitter had already been installed at the Leipzig station by mid-1953 [redacted] this station should also have the 3-kilowatt stage in operation sometime in 1954. [redacted] the 10-kilowatt transmitters 50X1-HUM were still being designed. reduced at the input to the amplifier by the pre-emphasis circuit in the ratio of 1:30. it was found that

5. One of the major difficulties [redacted] encountered in 50X1-HUM the manufacture of the 250-watt transmitters was in the construction of tubes which were free from microphonics. Other difficulties were encountered in the development of the necessary test and measuring equipment to be installed at each transmitting site, because of the required accuracy of this equipment. It was found necessary to this design and construct a measuring receiver for this purpose (see below). For example, the distortion factor in the 250-watt screen-transmitter was required to be 1.5 per cent or less. It was necessary therefore to design the measuring receiver with a distortion factor less than this amount. The major difficulty in this task was to reduce the distortion factor in the discriminator circuit.

Frequency Control and Adjustment

250-WATT FM TRANSMITTER 50X1-HUM

Control State Including Audio Frequency Amplifier and Modulation Stage

7. In order to tune the transmitter and maintain frequency stability by this indicator contains a high-stability circuit which compensates

6. [redacted] a schematic diagram of this transmitter. (See page 6.) The master oscillator is Hartley connected and oscillates at one eighth of the output frequency. For purposes of frequency stability a doition a ceramic form is used and the temperature of the circuit is controlled. In order to provide the most simple tuning possible, the buffer and limiter stage following the oscillator is gang-tuned with it. The buffer stage operates essentially as a limiter, reducing by a factor of five the traces of amplitude hat modulation which are unavoidable in frequency modulation. The proper anode circuit is a broad-band circuit in order not to allow any to additional amplitude modulation to arise, and puts out about 10 volts, which are fed to the multiplier and power stages by a low multi resistance cable. ance

10. The frequency produced by the master oscillator is multiplied by a factor of eight in four C O N F I D E N T I A L stages operate in push-pull. The power stage, which feeds into a tank circuit, also operates as a doubler stage in order to avoid self-excitation. Each stage is individually tunable.

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7. Frequency modulation is achieved by a push-pull arrangement, the principal advantage of which is that, with correct design, variations in the power voltage do not have any effect on the mean frequency. By this method, the reactance tubes will be modulated only by one half the amount of a given frequency variation, and by correct selection of a working point it is possible to avoid unsymmetrical distortions, which is necessary in view of the high demands made on the transmitter with respect to a small distortion factor. The only difficulty involved is that a transformer with the secondary winding operating in push-pull is required to supply the modulation voltage, which necessitates a certain degree of precision because of the required symmetry and the wide frequency range. About 10 volts$_{eff}$ are required for a frequency deviation of about plus or minus 10 kilocycles because the reactance tubes are grid modulated.

8. An audio frequency pre-amplification stage was found necessary because the transmitter was to be completely modulated by the voltage level existing on the modulation input lead. Since the incoming voltage will always be of the order of magnitude of one volt$_{eff}$ and the voltage is reduced at the input to the amplifier by the pre-emphasis circuit in the ratio of 1:30, it was found that an amplification of about 300 is required. The amplifier stages were designed in such a way, particularly by the use of negative feedback in the final stage, that the distortion factor remains smaller than 0.2 per cent. The frequency curve over the entire band must not deviate more than one decibel between 30 cycles and 15 kilocycles. Frequency-dependant negative feedback is proper in this case because of the resonances of the transformer. Reduction of noise and hum voltages necessitates the complete screening of the amplifier, good filtering of the power voltage, as well as the use of direct current for heating the filaments of the first amplifier tube and the oscillator.

Frequency Control and Adjustment

9. In order to tune the transmitter and maintain frequency stability by a factor of better than 3×10^{-5}, a frequency indicator is required. This indicator contains a high-stability circuit which compensates for frequency fluctuations which occur in operation. A discriminator circuit operating at about one third of the oscillator frequency was designed for this purpose. This circuit is temperature controlled and has a thermostat built in. In operation this discriminator circuit indicates frequency fluctuations of 2×10^{-5} on a scale and also reduces these deviations to one twentieth. The lower intermediate frequency of the discriminator is produced by mixing with the output of a quartz crystal. The crystals are mounted so that they are easily accessible and are changeable, so that with the proper crystal the frequency control equipment can be quickly adjusted to any desired frequency within the tuning range of the transmitter.

Multiplier and Power Stages

10. The frequency produced by the master oscillator is multiplied by a factor of eight in four stages. The last two stages operate in push-pull. The power stage, which feeds into a tank circuit, also operates as a doubler stage in order to avoid self-excitation. Each stage is individually tunable.

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11. The band widths of the individual circuits were given special attention and were chosen of such widths that no additional distortion factor would arise from the frequency modulated wave. The last three stages operate with class "C" bias.

MEASURING RECEIVER FOR FM TRANSMITTER

Range of Application

12. The measuring receiver is equipped for direct connection on the FM transmitter and is designed to determine the properties of the transmitter with respect to the audio frequency characteristics, the distortion factor, and the noise and hum voltages after FM and AM demodulation.

Principles of Construction

13. [redacted] sketch [redacted] a block diagram of this receiver /see page 7 /. 50X1-HUM
This receiver consists essentially of a linear measuring rectifier (frequency demodulator) and an audio frequency amplifier which makes it possible to measure directly with an indicating instrument the audio frequency voltage behind the demodulator and thus indicate the frequency deviation and audio frequency characteristic of the transmitter. Moreover, it provides an amplifier stage which makes it possible to measure noise and hum voltages as well as distortion voltages by means of a usual commercial millivoltmeter. By the use of a distortion factor measuring bridge the receiver provides matching at the input to the bridge. Furthermore, the receiver contains an AM demodulator. An oscillator with a mixer stage permits tuning to the frequency of the transmitter. Two intermediate frequency stages amplify the intermediate frequency thus obtained and limit the frequency modulated wave so that residual amplitude modulation of the transmitter does not influence the measuring results with respect to distortion factor. In order to guarantee the small self-distortion factor of the discriminator required for these measurements (about 0.1 per cent), it is necessary to check the demodulation characteristic curve from time to time. The built-in indicating instrument may also be used for this purpose by a simple reconnection.

14. It was found advisable to maintain the self-produced noise and hum voltages in the measuring receiver as small as possible so that the characteristics of the oscillator frequencies of the FM transmitters may also be determined correctly despite the relatively small frequency deviation.

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PRODUCTION OF OTHER MICROWAVE EQUIPMENT

15. [redacted] It is possible that such equipment is being produced [redacted] The only specific equipment [redacted] produced here was television equipment: a directional apparatus to transmit television programs from studios in Berlin

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Adlershof to the Neues Stadthaus in East Berlin, and the Leipzig television transmitter. 50X1-HUM

16. As a member of the SAG Kabel, HF Werk produced equipment for the USSR, only measuring and test equipment was involved. It is possible that other types of equipment were involved as well. 50X1-HUM

Equipment manufactured for the USSR included vacuum tubes voltmeters, a high power recording oscillograph of 50,000 kilometers per second recording speed, five high frequency spectrometers effective up to about 10 centimeters wavelength, a phase difference indicator, and electron microscopes (possibly two or three per year since development was completed in 1946), and five test television transmitters. 50X1-HUM

17. All of the equipment listed in the preceding paragraph as produced at HF Werk for the USSR is laboratory equipment and will be used for laboratory research rather than any special service or commercial application. 50X1-HUM

18.

19.

20. departments the transmitter development section. This section was located on the fifth floor of the building, about 50 persons were employed here. 50X1-HUM

no one was permitted to enter any section other than the one in which he was employed.

21. HF Werk produces only a very small percentage of the equipment developed here. This is because the capacity of HF Werk for large scale production is quite small, much smaller, for example, than that of Sachsenwerk Radeberg, particularly in the field of large types of equipment. 50X1-HUM

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22. Since 1951 only very small and isolated expansions have occurred at HF Werk. These expansions may have increased the floor area occupied by the plant by one tenth, but no more. In 1952, HF Werk took over part of the Knoyr Bremse Plant near the Ostkreuz Railroad Station in East Berlin. the space thus made available to HF Werk was to be used for the production of equipment developed by the experimental plant and also for testing of the finished equipment. 50X1-HUM

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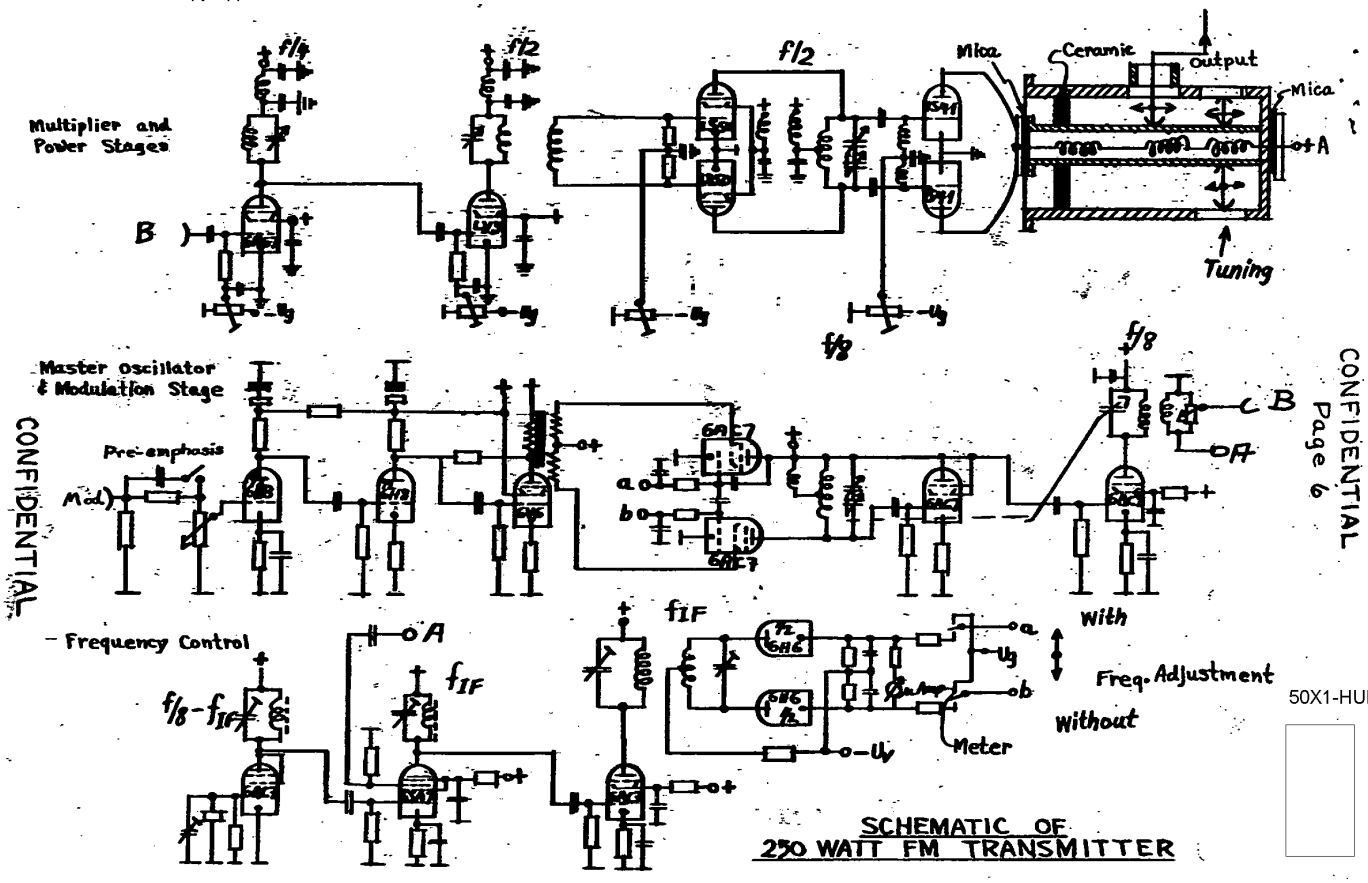

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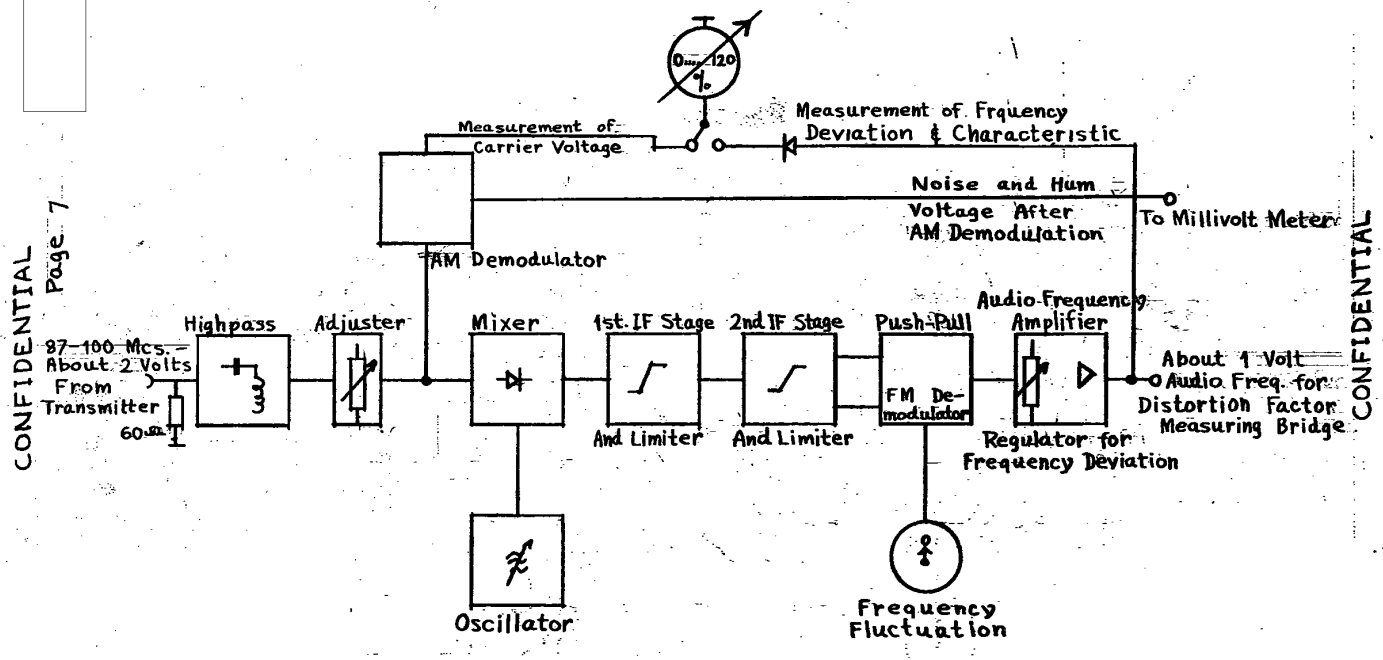

BLOCK DIAGRAM OF FM MEASURING RECEIVER